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A HUGE NEW XENOSAURID LIZARD FROM THE UPPER MIOCENE OF NEBRASKA

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A recent collection of fossils from the well-studied Norden Bridge local fauna (Upper Miocene) of Brown County, Nebraska, yielded the dorsal portion of the skull of an unexpected reptile, a very large xenosaurid lizard, *Nordenosaurus magnus*, new genus and species, with a probable snout–vent length of over 265 mm, and a probable total-length of over 530 mm. The fossil is assigned to the family Xenosauridae on the basis of a combination of characters unique to the family, including fused frontals, cranial sculpturing caused by the co-ossification of cranial osteoderms with each other and with the underlying bones, and the lack of expansion of the frontals anterior to the orbital emargination. But the fossil is not closely related to any fossil or living xenosaurid, thus it is assigned to a new subfamily, the Nordenosaurinae. It is suggested that the rarity of this strange form in the fossil record might be due to the possible arboreal habits of the lizard.

I here thank the members of the 1971 Michigan State University field party for their steadfast work in collecting fossils in Nebraska. I also thank Morris F. Skinner of the American Museum of Natural History for his aid in the field as well as for his helpful comments about the Tertiary stratigraphy of north-central Nebraska. The 1971 field work was supported in part by Grant Number 6034 of the Penrose Fund of the American Philosophical Society and in part by Grant Number 1459-71 of the Geological Society of America. Donna Rae Holman made the drawings.

The Fossil Site

Much collecting during the 1960's at the Norden Bridge local fauna (Upper Miocene) of Brown County, Nebraska, produced so many fossils representing poikilothermous vertebrates that a rash of papers appeared on fishes (Smith, 1962), amphibians (Tihen and Chantell, 1963; Chantell, 1964; Estes and Tihen, 1964; Chantell, 1966; and Meszoely, 1966), and reptiles (Estes and Tihen, 1964; Holman, 1964; and Meszoely, 1970). Thus, it might appear that the coldblooded fauna was well documented, and that continued collecting at the Norden Bridge site might produce diminishing returns. But in 1971, a small collection made at the Norden Bridge site by a Michigan State University Museum field party, yielded the remains of the startling new reptile.

The site lies in Brown County, Nebraska, near the Norden-Johnstown Road, about 300 yards south of the Norden Bridge across the Niobrara River at an elevation of 2170 feet in the SE ¼, SW ¼ of Sect. 33, T 33 N, R 23 W, Brown County, Nebraska. In July and August 1971, a collecting party from the Museum, Michigan State University led by J. A. Holman and consisting of George Cutts, Christopher King, Dan and Jane Lyons, and Robert Weigel, collected vertebrate fossils from sites which lie in what is presently known as the lower part of the Valentine Formation. The party processed 35 tons of matrix from a site designated the Egelhoff local fauna on the north side of the Norden Bridge in Keya Paha County, Nebraska, and processed a 5 ton sample of matrix from the classic Norden Bridge local fauna on the south side of the Norden Bridge in Brown County. This collecting was done mainly to document previous records, thus the party was surprised to find several noteworthy amphibians and reptiles as well as the huge xenosaurid lizard, by far the most interesting lower vertebrate thus far recorded from the fauna.

The Norden Bridge local fauna beds are presently undergoing stratigraphic revision and they represent a heretofore unnamed lithologic unit whose mammalian remains indicate Barstovian (Upper Miocene) as well as Clarendonian (Lower Pliocene) relationships (Morris F. Skinner, personal communication, November 1972). I consider the Norden Bridge

TABLE 1.—Classification and distribution of Xenosauridae (modified from McDowell and Bogert, 1954)

Family Xenosauridae	Upper Cretaceous to Recent
Subfamily Melanosaurinae	
Genus *Melanosaurus*	Lower Eocene, Wyoming
Subfamily Shinisaurinae	
Genus *Exostinus*	Upper Cretaceous to Middle Oligocene, Western North America
Genus *Necrosaurus*	Middle Eocene, Europe
Genus *Shinisaurus*	Recent, Southern China
Subfamily Nordenosaurinae	
Genus *Nordenosaurus*	Upper Miocene, Nebraska
Subfamily Xenosaurinae	
Genus *Xenosaurus*	Recent, Mexico to Guatemala

site as well as the Egelhoff site to represent Upper Miocene rather than Lower Pliocene times based on the presence of boid snakes and archaic colubrid snake genera that are absent from well-known Upper Pliocene (Clarendonian) herpetofaunas in the Great Plains (Holman, 1972, paper given at Society of Vertebrate Paleontology Meetings, Lincoln, Nebraska).

FAMILY XENOSAURIDAE

The fossil is assigned to the family Xenosauridae (Table 1) on the basis of (1) the fused frontals, (2) the co-ossification of the cranial osteoderms with each other as well as with the underlying bones producing a sculpturing that is characteristic of the Xenosauridae as compared with the Anguidae, and (3) the lack of anterior expansion of the frontals anterior to the orbital emargination.

Nordenosaurinae, new subfamily

Diagnosis: Very large lizards of the family Xenosauridae with the skull very narrow in the interorbital region; with the anterior edge of the fused frontals straight; and with a cranial sculpturing of round pits interspersed among irregular ridges.

Nordenosaurus, new genus

Diagnosis: *Nordenosaurus* may be separated from the living genera *Xenosaurus* and *Shinisaurus* on the basis of the deep rounded pits in the cranial sculpturing which are lacking in the latter two genera. Moreover, *Nordenosaurus* has the anterior edge of the fused frontals straight, whereas in *Xenosaurus* and *Shinisaurus* this edge is deeply incised.

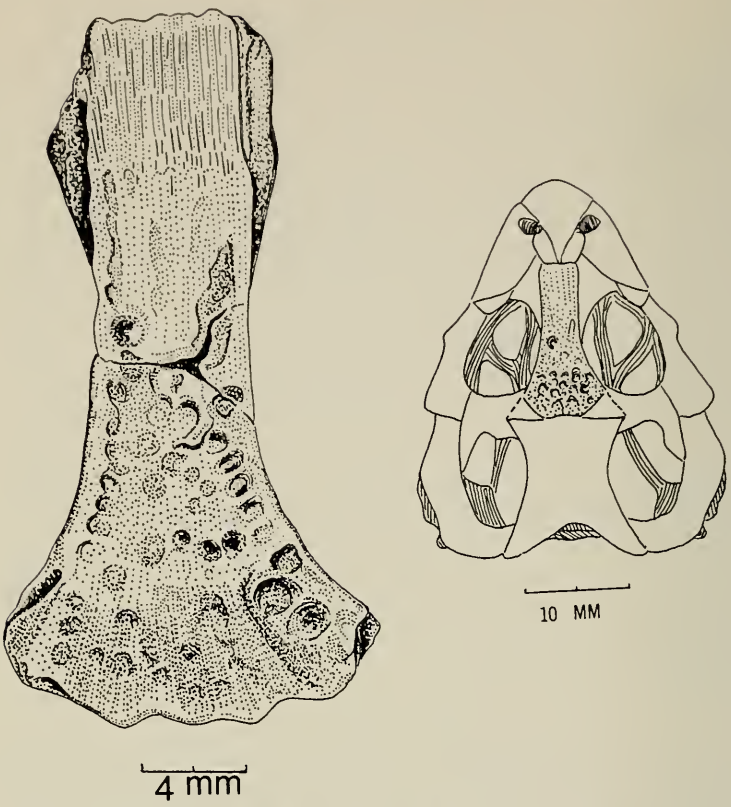

Fig. 1. Left, *Nordenosaurus magnus*, new genus and species; holotype, MSU-VP-715, dorsal portion of skull consisting of fused frontals, dorsal view. Right, reconstruction of skull of *Nordenosaurus magnus* (based on a Recent *Xenosaurus grandis* skull) to indicate the size of *N. magnus*; stippled area represents actual fossil.

Finally, *Nordenosaurus* is a much larger lizard than either *Xenosaurus* or *Shinisaurus*.

Nordenosaurus may be separated from *Exostinus* of the Upper Cretaceous, Upper Paleocene, and Middle Oligocene of western North America on the basis of the much larger size of *Nordenosaurus* and the lack of a knobbed sculpturing of the cranial bones in *Nordenosaurus*. *Nordenosaurus* may be separated from *Melanosaurus* of the Lower Eocene of Wyoming on the basis of the narrow interorbital region of the skull of *Nordenosaurus* (narrowest interorbital distance into length of frontals more than two times in *Nordenosaurus*, less than two times in

TABLE 2.—Measurements (mm) of *Nordenosaurus magnus* compared with adult *Xenosaurus grandis*

	Nordenosaurus		*Xenosaurus*	
Greatest length of fused frontals	actual	28.0	actual	12.5
Head length	estimated	66.3	actual	29.6
Head width	estimated	49.3	actual	22.0
Snout–vent length	estimated	265.2	actual	118.4
Total length	estimated	530.4	actual	236.8

Melanosaurus). Moreover, in *Nordenosaurus* the cranial sculpturing is produced by rounded pits and irregular ridges, in *Melanosaurus* the sculpturing is produced by a fine tuberculation.

Nordenosaurus magnus, new species

Holotype: Dorsal portion of a skull consisting of the fused frontal bones, Michigan State University, Museum, Vertebrate Paleontology Number 715 (Fig. 1).

Referred bones: Two fragments of skull bones, MSU-VP-716.

Type-locality: Norden Bridge local fauna (Upper Miocene) of Brown County, Nebraska. Near the Norden-Johnstown Road, about 300 yards south of the bridge across the Niobrara River in the SE ¼, SW ¼, of Sect. 33, T. 33 N, R. 23 W, Brown County, Nebraska.

Diagnosis: As for the genus.

Description of the holotype: The holotype, MSU-VP-715 represents the dorsal portion of a skull, consisting of a pair of fused frontal bones. The fossil is 28 mm long and it is 12.5 mm wide through the interorbital region. In dorsal view, the sculpturing on the posterior half of the fossil is more pronounced than it is on the anterior half where on the last few millimeters the sculpturing becomes a series of thin, anteroposteriorly directed parallel ridges or striae. The main sculpture pattern consists of rounded pits, some larger and deeper than others, with these pits being interspersed among irregular ridges. Some of the larger pits on the posterior part of the bone are over 1 mm in diameter. The fossil is widest at the posterior end where it measures 15 mm and it is narrowest in the interorbital region where it measures 12.5 mm. The width at the anterior end is 13.5 mm. The anterior edge of the fossil is straight. Along each side of about the anterior one-third of the bone the articular surfaces for the prefrontals are produced laterally beyond the dorsal rims of the orbits.

In lateral view, there is a pronounced supraorbital shelf that runs the full length of the fossil. Below the supraorbital shelf occupying about the anterior one-half of the lateral surface of the fossil is a deep groove for the insertion of the prefrontal articular processes. Below this groove are ridges and pits that produce a sculptured surface. The diameter of

FIG. 2. Photograph of living *Xenosaurus grandis* from Cuautlapan, Veracruz, Mexico, to show the cranial tuberculation that produces the sculpture pattern on the skull bones of the Xenosauridae.

the orbit appears to have been about 15 or 16 mm. The notch for the reception of the postfrontal at the posterior end of the fossil is much less excavated than the notch for the prefrontal.

In ventral view, the most obvious features are the ventrally extending ridges forming the lateral borders of the cranial cavity. At the middle of the fossil these ridges come within 3 mm of each other. It is interesting to note that the entire ventral surface of the fossil is sculptured, but not as strongly as the dorsal surface.

Estimated size of the lizard: Assuming that *Nordenosaurus* had body proportions (Table 2) somewhat like a Recent *Xenosaurus grandis* from Cuautlapan, Veracruz, Mexico, estimated measurements of the fossil lizard are as follows: head length, 66.3 mm; head width, 49.3 mm; snout to vent length, 265.2 mm; total length, 530.4 mm. The fossil was a large, powerful lizard, a veritable giant compared with living *Xenosaurus* and *Shinisaurus*.

DISCUSSION

The occurrence of a very large xenosaurid lizard as a part of the Norden Bridge herpetofaunal assemblage is quite unexpected. The amphibian fauna of the Norden Bridge site is rather drab, with many forms referred to living species and all genera being extant ones, with the exception of the large salamander *Andrias*. The previously de-

TABLE 3.—Distribution of American Fossil Xenosauridae

Age and locality	Taxon	Latest Reference
Upper Cretaceous, Lance Formation, Wyoming	*Exostinus lancensis* Gilmore	Estes, 1964
Upper Paleocene, Polecat Bench Formation, Wyoming	*Exostinus rugosus* Gilmore	Estes, 1965
Lower Eocene, "Wasatch Formation," Wyoming	*Melanosaurus maximus* Gilmore	McDowell and Bogert, 1954
Middle Oligocene, White River Series, Colorado	*Exostinus serratus* Cope	Estes, 1965
Upper Miocene, lithic unit to be named, Nebraska	*Nordenosaurus magnus* Holman	This paper

scribed reptile fauna is a little more interesting as giant tortoises, small boid snakes, and some archaic colubrid snake genera are present; but nothing as bizarre as the large xenosaurid lizard has heretofore been reported from the coldblooded fauna of the site.

Possible ecological role of Nordenosaurus: Today only two living genera, each in a monotypic subfamily, represent the family Xenosauridae; *Xenosaurus* (Fig. 2), which ranges from Mexico to Guatemala and is represented by three species, *X. grandis*, *X. newmanorum*, and *X. platyceps* (King and Thompson, 1968) and *Shinisaurus* which is known only from the mountainous Yaoshan region of eastern Kwangsi in southern China and is represented by one species, S. *crocodilurus*. *Shinisaurus* is said to live along streams and to feed partly upon tadpoles and fish, but beyond this nothing much is known about its habits. The food habits of *Xenosaurus* are not known, although King and Thompson (1968) presume they feed mainly on soft-bodied invertebrates, particularly arthropods. I kept a living *Xenosaurus grandis* from Cuautlapan, Veracruz, Mexico, in captivity for almost 2 years, and I found that when kept at a warm temperature the lizard was rather aggressive and would feed upon a variety of small animals, including large cockroaches (*Nauphoeta*) and small mice (*Mus musculus*). The jaws were very strong and the lizard could produce a painful bite that would break the skin of an adult human hand.

Therefore, considering its large size, *Nordenosaurus* must have been an important predator on small vertebrates, eating smaller lizards, snakes, small mammals, and possibly birds and their eggs.

One modern form, *Xenosaurus grandis arboreus* from the Isthmus of Tehuantepec in Mexico is arboreal and lives in tree-holes in standing

trees (Lynch and Smith, 1965). If indeed *Nordenosaurus* was arboreal, this would suggest a reason why this large form is represented in the geological record by only one fossil; for it is axiomatic that arboreal forms such as birds and primates are among the rarest of vertebrate fossils.

Phylogenetic relationships: Other than the unquestionable assignment of *Nordenosaurus* to the family Xenosauridae, it is difficult to suggest its relationships to living forms or to fossil forms (Table 3). *Nordenosaurus* is about as large as *Melanosaurus* of the Lower Eocene of Wyoming, but it differs from this form in strong characters (see diagnosis). *Nordenosaurus* is much larger and differs in strong characters from the Cretaceous and early Tertiary American genus *Exostinus* and the living genera *Xenosaurus* and *Shinisaurus*. Thus I have assigned the Nebraska fossil genus to a subfamily of its own, the Nordenosaurinae, and I suggest it was a dead-end form with no living relatives.

Literature Cited

Chantell, C. J. 1964. Some Mio-Pliocene hylids from the Valentine Formation of Nebraska. Amer. Midl. Nat. 72:211–225.

———. 1966. Late Cenozoic hylids from the Great Plains. Herpetologica 22:259–264.

Estes, R. 1964. Fossil vertebrates from the late Cretaceous Lance Formation, eastern Wyoming. Univ. Calif. Publ. Geol. Sci. 49:1–187.

———. 1965. Notes on some Paleocene lizards. Copeia 1965:104–106.

Estes, R. and J. A. Tihen. 1964. Lower vertebrates from the Valentine Formation of Nebraska. Amer. Midl. Nat. 72:453–472.

Holman, J. A. 1964. Fossil snakes from the Valentine Formation of Nebraska. Copeia 1964:631–637.

King, W. and F. C. Thompson. 1968. A review of the American lizards of the genus *Xenosaurus* Peters. Bull. Fla. State Mus. Biol. Ser. 12:93–123.

Lynch, J. D. and H. M. Smith. 1965. A new species of *Xenosaurus* (Reptilia:Xenosauridae) from the Isthmus of Tehuantepec, Mexico. Trans. Kans. Acad. Sci. 68:163–172.

McDowell, S. B. and C. M. Bogert. 1954. The systematic position of *Lanthanotus* and the affinities of the anguinomorph lizards. Bull. Amer. Mus. Nat. Hist. 105:1–142.

Meszoely, C. 1966. North American fossil cryptobranchid salamanders. Amer. Midl. Nat. 75:495–515.

———. 1970. North American fossil anguid lizards. Bull. Mus. Comp. Zool. 139:87–150.

Smith, C. L. 1962. Some Pliocene fishes from Kansas, Oklahoma and Nebraska. Copeia 1962:505–520.

Tihen, J. A. and C. J. Chantell. 1963. Urodele remains from the Valentine Formation of Nebraska. Copeia 1963:505–510.